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Sensor Enhanced Armor Non Destructive Evaluation Laboratory

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Report Documentation Page

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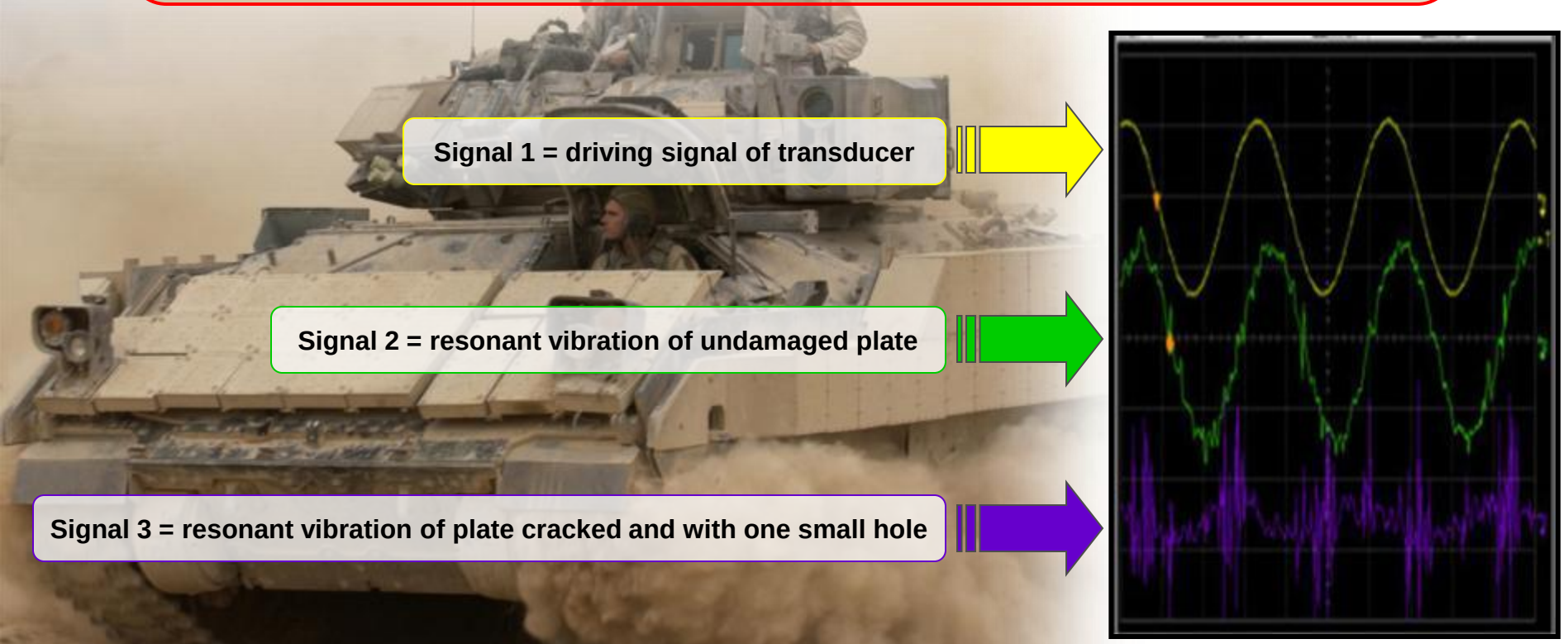
Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Armor Full Life Cycle NDT/NDE

Ground Vehicle Survivability Sensor Enhanced Armor and NDT/NDE

- Survivability role – identify, characterize and integrate sensors and technologies for various armor recipies.
- Prototype sensor enhanced armor on vehicle demonstrators.
- Lead the Army armor NDE/NDT life cycle integration effort.



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TARDEC-wide Involvement
Sensor Enhanced Armor

- Project is looking at a variety of ways to assess health of armor over life of vehicle (including prior to installation).
- Making vehicle more intelligent, increase survivability for vehicle and soldier, cost effective, more real time status, health of armor and vehicle.
- Portray capability to scan all types of armor with some type of wave/sound/light – data shows cracks/no cracks.

TARDEC groups involved: **Survivability, Intelligent Ground Vehicle Systems, Condition Based Maintenance**

Industry: **General Dynamics / BAE**

Academia: **Michigan State University, University of Michigan, Wayne State University, Oakland University (supporting background research ways to measure health of armor)**

Audience: **future customers, other government labs, contractors, not so much universities**

PARTNERS

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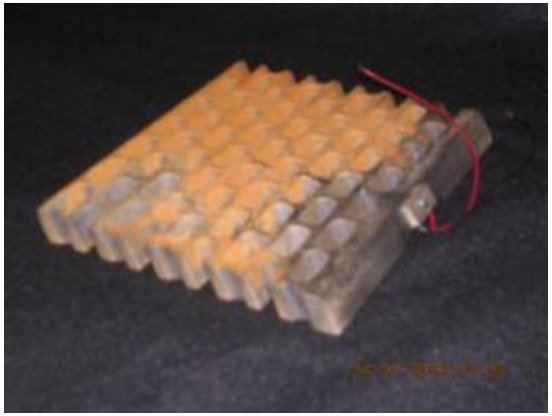
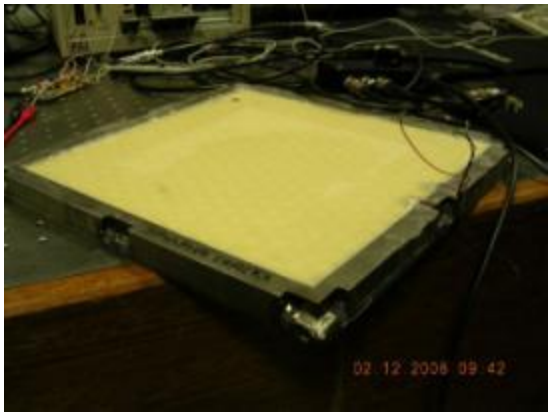
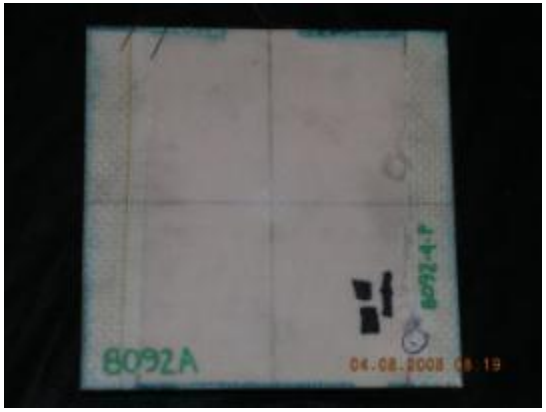
Armor Solutions Tested with Ultrasonics

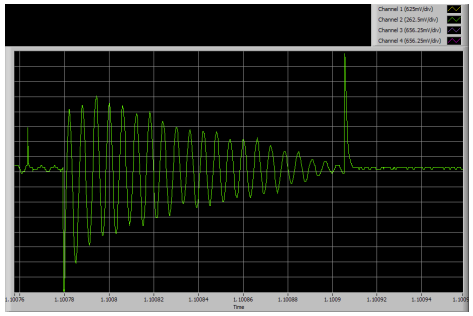
NDT/E leading to Sensor Enhanced Armor

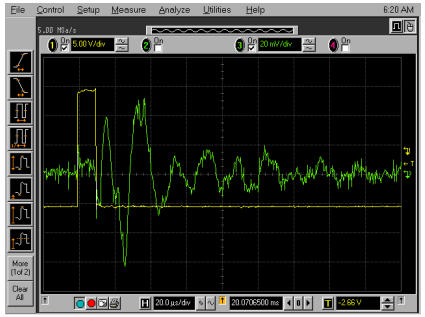


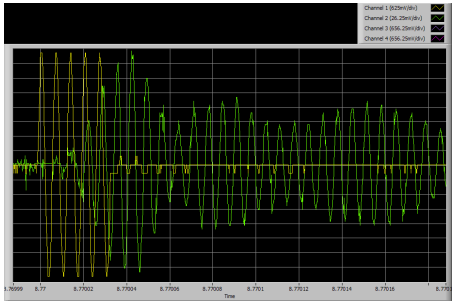




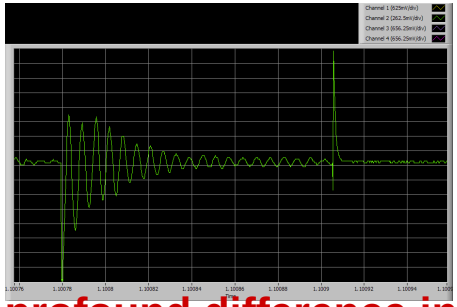
Undamaged

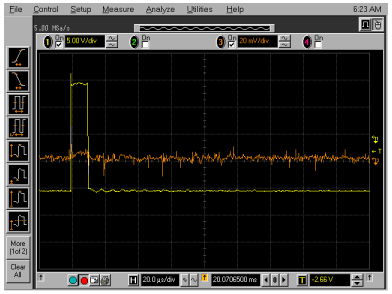


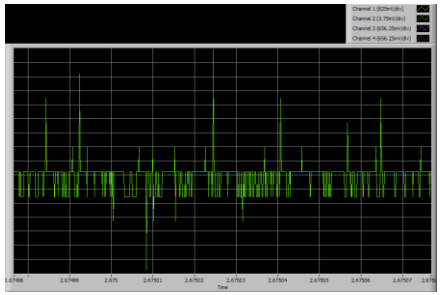




Damaged

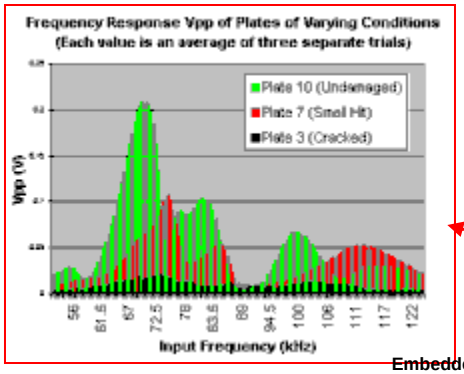




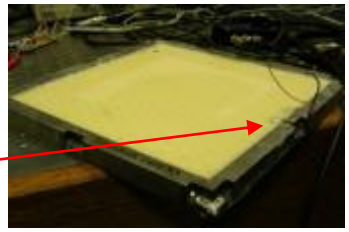


There is a profound difference in the shape and amplitude of the echo signal between the damaged and undamaged plates. Tests are underway using embedded transducers for real-time armor integrity monitoring.

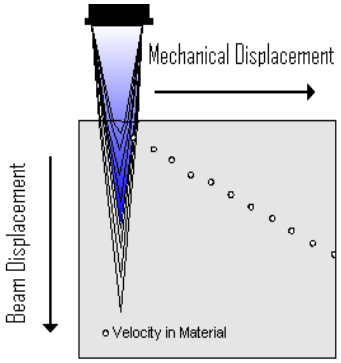
Armor Nondestructive Testing Laboratory



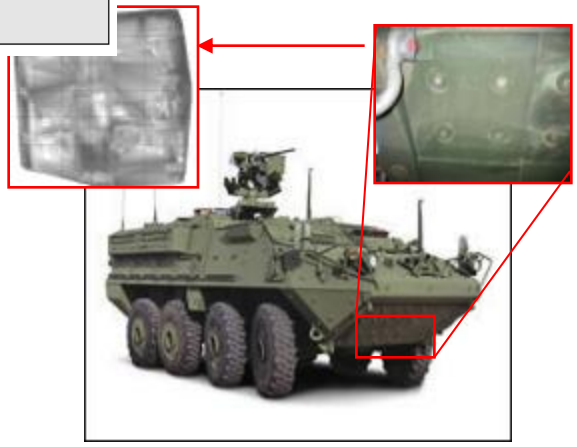
Handheld Prototype Testing Device



Embedded sensors



Phased Array Ultrasonic Scanning in H20



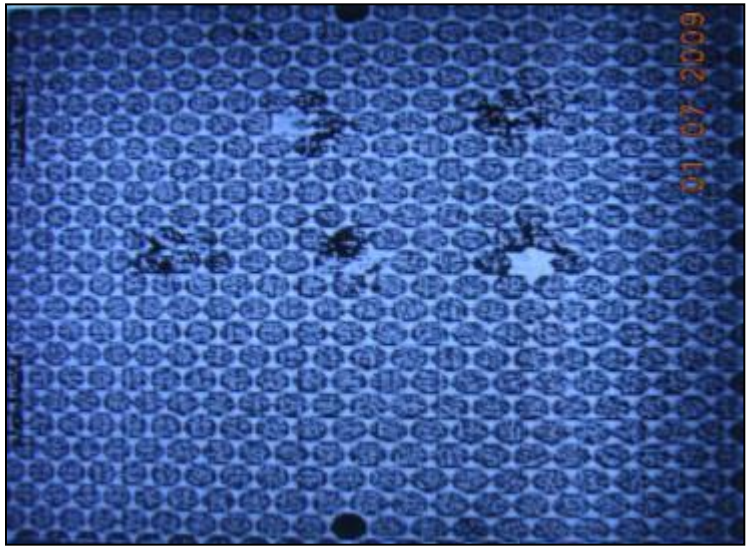
mm Wave Scanning technology (multiple layers)

Mission:
- Develop methods to evaluate the integrity of armor designs during the manufacturing, at the depot, in the field and on the vehicle while in use.

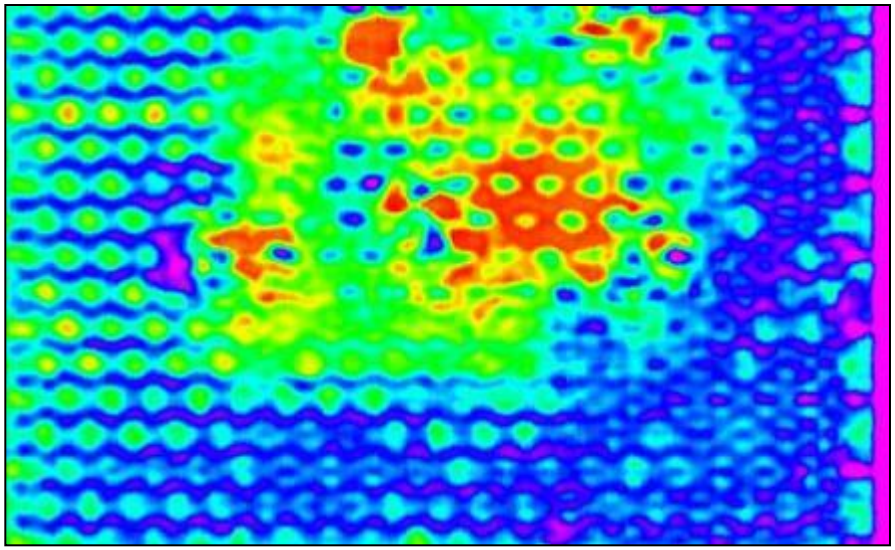
Objective:
- Provide NDT/NDE for armor throughout the life cycle of the vehicle
- Design embedded health monitoring solutions for various armor solutions.
- Provide ultrasonic, x-ray and mmwave imaging for armor damage analysis.
- Explore various NDE options to support all armor recipies

Method:
- Use the latest NDE technology to mature armor solutions for cost reduction through improved reliability
- Design embedded health monitoring solutions for various armor solutions.
- Provide ultrasonic, x-ray and mmwave imaging for armor damage analysis.
- Explore various NDE options to support all armor recipies

X-ray and mm wave image of pellet armor

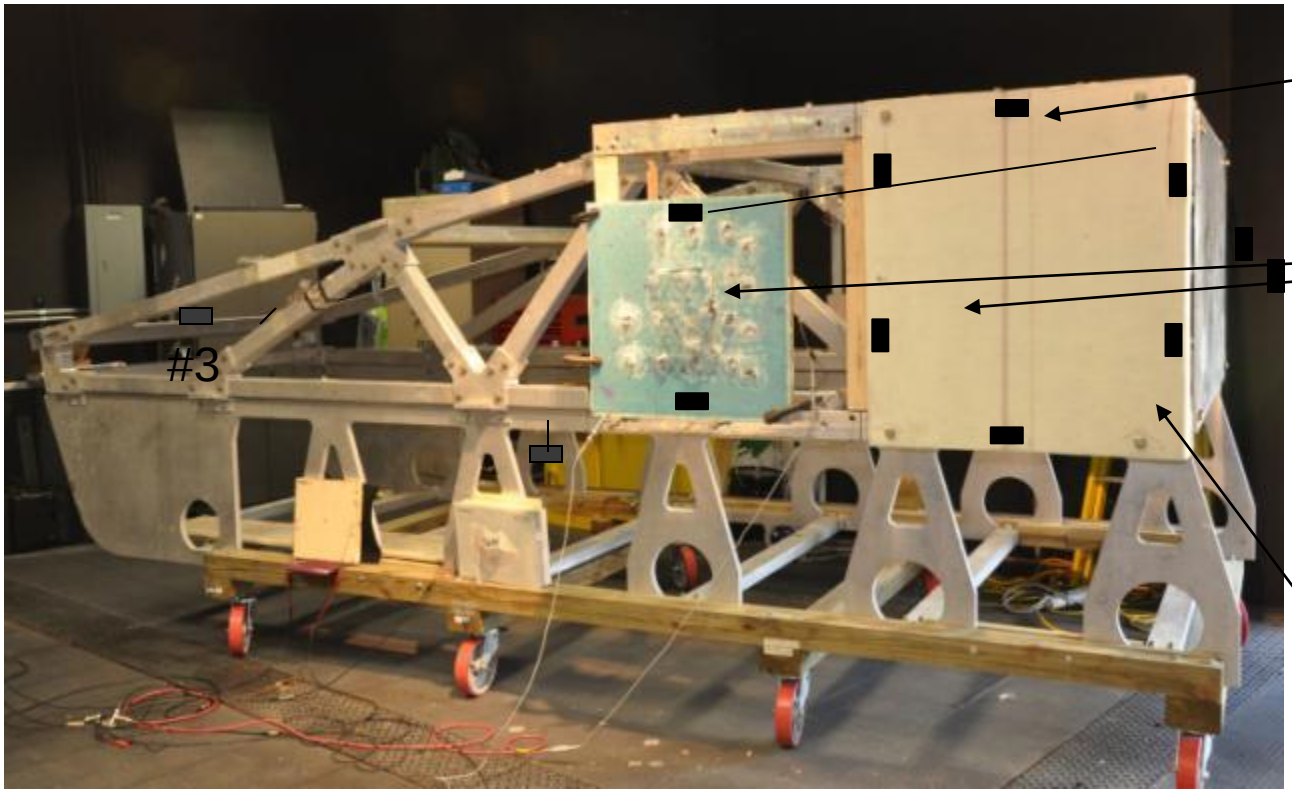


X-ray image



Mmwave Image

Smart Armor
Demo Vehicle Frame



Embedded Transducers

Sensor Enhanced Armor panels

Survivability NDT/NDE Laboratory

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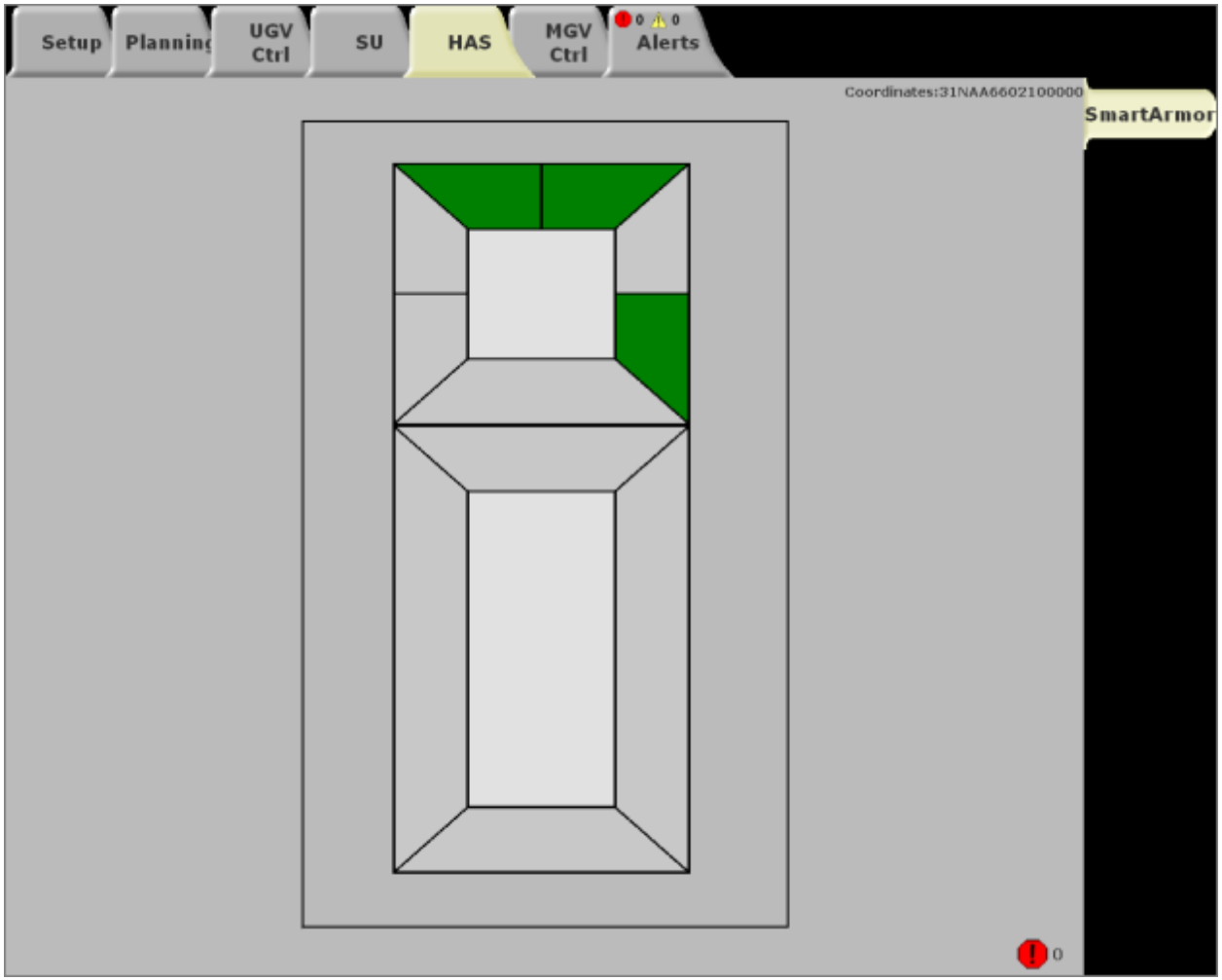
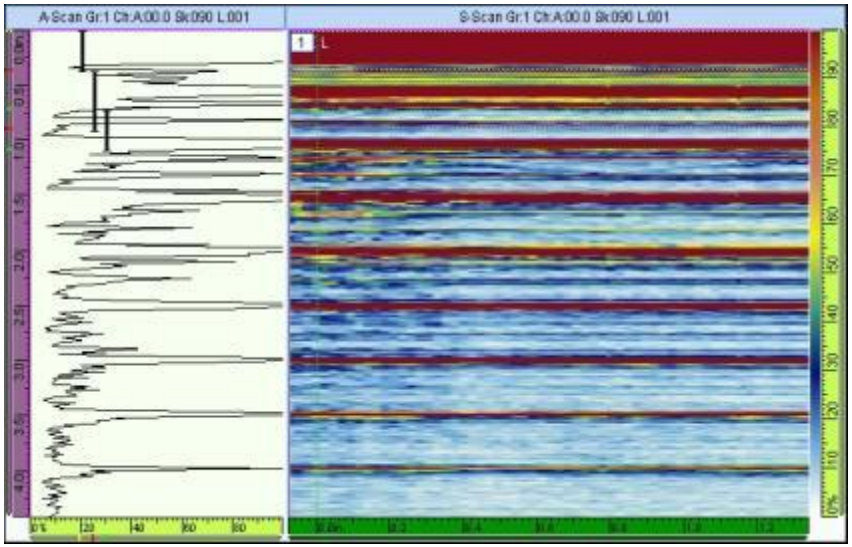
Vehicle Display Views – Healthy Armor



NDE of Transparent Materials

Transparent Materials



Phased Array Ultrasound Image

Uses of NDE and Health Monitoring

- Health Monitoring during normal vehicle usage, before battle use or damage and performed at certain time intervals.
- Determination of the severity, identification, and location of ballistic impacts to the armor while the vehicle is being used in battle. An active NDE system could tell the commander of any vulnerabilities and or what areas need repair to stay in battle.
- Communication to neighboring forces integrity of armor and or severity of impacts.
- Assessment of armor integrity between missions. This would be done at the depot level and would involve NDE and health monitoring to test for any armor defects or flaws as well as internal damage that could lead to armor failure.
- There is a need for system integration at the armor level.